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(54) Straight stem for the implantation into a proximal femur

(57) The present disclosure relates to a straight stem (10) for the implantation into a proximal femur the stem (10) comprising a proximal stem section (12) and a distal stem section (14) having a distal end (24), the proximal stem section (12) comprising a connection portion for connecting a neck (16) to the stem (10), the connection portion comprising a collar (18) having, in an anterior-posterior view, a medial contour, the stem (10) having, in an anterior-posterior view, a medial contour and a lateral contour, and the stem (10) having a straight stem center axis (20) between the medial contour and the lateral contour, wherein the medial contour of the stem (10) comprises a concavely curved section extending between a straight medial section (46) and the collar (18), wherein the concavely curved section of the medial contour comprises at least first and second curved sections, the first curved section merging with the straight medial section (46) and the second curved section merging with the medial contour of the collar (18), and wherein the degree of curvature of the first curved section is smaller than the degree of curvature of the second curved section.

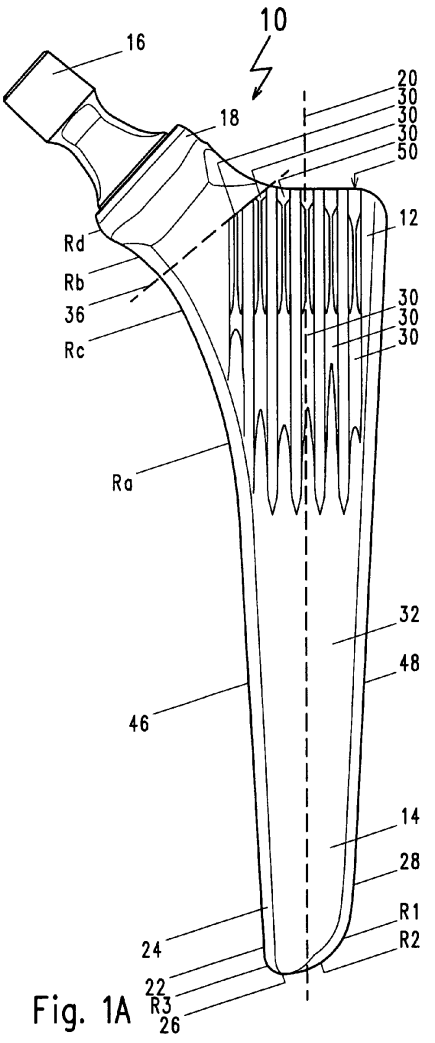

Fig. 1A

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Description

[0001] The present disclosure relates to a straight stem for the implantation into a proximal femur.

[0002] During hip replacement surgery a hip implant is generally used to replace the hip joint. During total hip arthroplasty a femoral stem is introduced into a proximal part of the femur of a patient. The recovery times are frequently long. Moreover, as a hip implant has a limited lifetime, bone conservation is an important aspect of total hip arthroplasty, particularly for younger patients. By removing as little bone as possible during a primary operation, the surgeon leaves more options for any potential future revision surgery. Moreover, it is important to reduce stresses which may arise where the implanted stem is in contact with the bone.

[0003] One object of this disclosure is therefore to provide a straight stem whose stem design helps prevent undue stresses in the bone from arising.

[0004] Accordingly, the present disclosure provides a straight stem for the implantation into a proximal femur. The stem comprises a proximal stem section and a distal stem section having a distal end, the proximal stem section comprising a connection portion for connecting a neck to the stem, the connection portion comprising a collar having, in an anterior-posterior view, a medial contour. The stem has, in an anterior-posterior view, a medial contour and a lateral contour, and the stem has a straight stem center axis between the medial contour and the lateral contour. The medial contour of the stem comprises a concavely curved section extending between a straight medial section and the collar. The concavely curved section of the medial contour comprises at least first and second curved sections, the first curved section merging with the straight medial section and the second curved section merging with the medial contour of the collar. Moreover, the degree of curvature of the first curved section is smaller than the degree of curvature of the second curved section.

[0005] It has been found that the medial contour of the stem as disclosed herein permits a good insertion of the stem into the patient's femur and a good reproduction of the femur's shape even if a pronounced collar is provided at the stem for the reception of a modular femoral neck. Thus, the present disclosure enables the use of a medial contour which is ideal for reproducing the patient's anatomy and at the same time allows for a smooth transition into the collar.

[0006] The medial contour of the stem as disclosed herein is of particular advantage for a straight stem. Generally, one distinguishes between straight stems, anatomical stems and curved stems. The present disclosure relates to straight stems. While the use of curved stems allows a complete preservation of the Great Trochanter, the implantation of straight stems is aimed at the longitudinal axis of the femur. Thus, only straight stems allow a clear definition of a stem center axis between the medial contour and the lateral contour of the stem. Moreover, a straight stem has a relatively long straight section on the lateral side and also on the medial side. Typically, these straight sections define a taper of the stem in a frontal view of approximately 5 to 6°, while substantially planar anterior and posterior surfaces of the stem define a taper of the stem in a lateral view of approximately 1.5 to 2°.

[0007] In an embodiment the medial contour of the collar is convexly curved.

[0008] A convexly shaped medial contour of the collar provides the collar with material to reinforce the interface at which a modular femoral neck can be inserted into the stem.

[0009] In a further embodiment the first and second curved sections of the medial contour have a radius of curvature Ra and Rb, respectively, wherein $5 * Rb \leq Ra \leq 10 * Rb$. This can provide for an advantageously smooth transition from the medial straight section up to the collar of the stem.

[0010] In a further embodiment the medial contour of the stem has at least one third curved section between the first and second curved sections, the degree of curvature of the third curved section being different from the degrees of curvature of the first and second curved sections. This third curved section can provide for an even smoother transition from the medial straight section up to the collar of the stem.

[0011] In a further embodiment the third curved section has a radius of curvature Rc, wherein $Rb < Rc < Ra$, in particular wherein $2 * Rc \leq Ra \leq 5 * Rc$.

[0012] In a further embodiment the degree of curvature of the medial contour of the stem increases from the merging point between the straight medial section and the first curved section to the merging point between the second curved section and the convexly curved contour of the collar.

[0013] This increasing degree of curvature between the merging point of the straight medial section and the convexly curved contour of the collar ensures that the concave shape of the medial contour has a stronger curve at the collar than at the merging point with the straight medial section. Moreover, the reduction of the degree of curvature towards the straight medial section ensures a smooth transition of the stem from the collar to the straight medial section.

[0014] In a further embodiment adjacent ones of the sections of the medial contour of the stem and of the collar merge at a common point, wherein each pair of adjacent sections have a common tangent at their common point. Having a common tangent at their common point ensures smooth transitions between the adjacent contours of the stem.

[0015] In a further embodiment the first curved section has a radius of curvature Ra which is in the range of 50mm to 150mm, in particular in the range of 80mm to 120mm, and/or wherein the second curved section has a radius of curvature Rb which is in the range of 5mm to 25mm, in particular in the range of 10mm to 20mm, and/or wherein the third curved section has a radius of curvature

Rc which is in the range of 15mm to 45mm, in particular in the range of 20mm to 40mm.

[0016] These size ranges for the different radii of curvature of the medial concave contour ensure that a smooth curved concave medial contour of the stem and also a smooth transition into the collar can be realized.

[0017] In a further embodiment, the stem is provided with an asymmetrically convexly curved contour of the distal end.

[0018] In one embodiment, the distal stem section has a distal tip arranged directly adjacent the distal end and defining a distalmost point of the distal end, wherein the distal end, in an anterior-posterior view, has a convexly curved contour, wherein the convexly curved contour of the distal end merges with straight sections of the medial contour and of the lateral contour at a medial merging point and a lateral merging point, respectively, and wherein the medial merging point and the lateral merging point are offset with respect to each other in a direction parallel to the stem center axis, the lateral merging point being arranged proximally with regard to the medial merging point.

[0019] In another embodiment, the distal stem section has a distal end and a distal tip arranged directly adjacent to the distal end and defining a distalmost point of the distal end. The distal end of the stem, in an anterior-posterior view, has a convexly curved contour. The convexly curved contour of the distal end merges with straight sections of the medial contour and of the lateral contour at a medial merging point and a lateral merging point, respectively. The convexly curved contour of the distal end is such that the distal tip is medially offset with respect to the stem center axis.

[0020] An asymmetrically convexly curved contour of the distal end of the stem ensures a smooth transition on the lateral contour in the region where - in the implanted state - the stem gets out of contact with the bone. Moreover, as the length of the laterally rounded portion of the distal end is relatively long, high stresses can be reduced, as less pressure is applied to that portion of the femoral bone.

[0021] As no sharp corners or other protrusions are present on the lateral contour of the stem, the forces arising under load are deflected or distributed along the lateral contour of the stem and prevent local high pressure fields from arising.

[0022] If the distal tip is medially offset with respect to the stem center axis, the distal end can be provided with an even longer lateral convex portion which ensures an improved force deflection or distribution along the lateral distal end of the stem reducing the stresses arising there.

[0023] The curved contour of the distal end of the stem as disclosed herein is of particular advantage for a straight stem. Providing a straight stem with a distal end which is curved as disclosed herein provides for a relatively long lateral support for the stem at the bone without the need for an excessive length of the stem or for overly strong curvatures at the distal end of the stem, and thus without the occurence of local high pressure fields even under high loads.

[0024] In a further embodiment the convexly curved contour of the distal end has a curved medial section extending between the distal tip and the medial merging point and a curved lateral section extending between the distal tip and the lateral merging point, wherein the contour of the distal end is asymmetrically convexly curved such that the degree of curvature of the curved lateral section is smaller than the degree of curvature of the curved medial section.

[0025] In a further embodiment the curved lateral section of the distal end is defined by at least one radius of curvature R 1, and wherein $100mm \leq R\,1 \leq 200mm$. This radius ensures an advantageously smooth transition of the straight stem up to the distal tip of the stem.

[0026] In a further embodiment the stem has a lateral shoulder, the stem center axis extending between the distal end and the lateral shoulder. The straight section of the lateral contour of the stem may extend from the distal end to the lateral shoulder. In a transverse plane the cross section of the stem may have a generally rectangular shape along the stem center axis between the distal end and the lateral shoulder.

[0027] In a further embodiment the stem has an anterior surface and a posterior surface which are substantially planar at least in the distal stem section, wherein the stem tapers towards the distal end in a frontal plane as well as in a sagittal plane, the frontal plane taper being defined by the straight sections of the medial and the lateral contours of the stem, and the sagittal plane taper being defined by the planar anterior and posterior surfaces of the stem.

[0028] The different embodiments described above in accordance with the scope of the independent claims and the features realized there can naturally be combined with one another.

[0029] Further embodiments of the disclosure are also recited in the dependent claims, the description and the drawings.

[0030] Further areas of applicability of the present disclosure will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples are intended for the purpose of illustration only and are not intended to limit the scope of the disclosure in any way. The figures are simplified and schematic. Details not necessary for the understanding of the disclosure are omitted.

[0031] The present disclosure will be explained in more detail and become fully understood from the detailed description and the accompanying drawings, wherein

Fig. 1A shows a perspective view of an embodiment of the straight stem;

Fig. 1B shows a different perspective view of the embodiment shown in Fig. 1A;

Fig. 2 shows a further embodiment of a straight stem;

Fig. 3A shows an embodiment of a straight stem;

Figs. 3B to 3J show different sectional illustrations of the embodiment shown in accordance with Fig. 3A; and

Fig. 4 shows a further embodiment of a straight stem.

[0032] All anatomical terms relating to directions or locations, such as anterior, posterior, medial, lateral, proximal and distal, refer to an implanted state of the components and implants described herein.

[0033] Fig. 1A shows an embodiment of a straight stem 10 having a proximal stem section 12 and a distal stem section 14. The straight stem 10 shown in Fig. 1A is of a specific size and will be described with reference to this size. Naturally speaking specific parameters used to describe this size can deviate throughout the different ranges of stem sizes used.

[0034] A medial part of the proximal stem section 12 has a modular femoral neck 16 installed on a collar 18. The modular femoral neck 16 is aligned in accordance with a patient's CCD angle relative to a stem center axis 20 following installation thereof and serves to carry a femoral head (not shown). The collar 18, also referred to as yoke, of the neck portion is dimensioned such that it can receive the modular femoral neck 16 and impart sufficient support to the modular femoral neck 16 under load. Modular femoral necks 16 which can be introduced into the stem 10 are used, as they provide a surgeon with the ability to precisely match a wide range of male and female patient anatomies without compromise, as a high variability in femoral head height and offset has been found among patients, and the modular femoral necks 16 allow the surgeon to efficiently respond intra-operatively to excessive femoral deviations and also to discrepancies which can arise e.g. due to X-ray templating etc.

[0035] To allow a femoral stem 10 to receive a modular femoral neck 16 the collar 18 of the stem 10 has to be reinforced. For this reason the collar 18 has a generally convexly curved outer contour Rd whose medial contour merges with the concavely curved medial contour (Ra, Rc, Rb) of the proximal stem section 12.

[0036] In the above embodiment the concavely curved medial contour Ra, Rc, Rb merges with a straight stem section 46 at an intermediate region of the stem 10 which defines the transition from the proximal stem section 12 into the distal stem section 14. At a medial merging point 22 the medial straight section 46 merges into a distal end region 24 of the stem 10 having a generally convex shape R1, R2, R3.

[0037] In the present embodiment the convex shape of the distal end region 24 has a distal tip 26 as its most distal point which also defines a mathematical turning point with regard to the convexly shaped distal end region 24. The distal tip 26 is also medially offset with respect to the stem center axis 20. The convexly shaped distal end region 24 also has a curved lateral region R1, R2 which extends from the distal tip 26 up to a lateral merging point 28.

[0038] The curved lateral region R1, R2 then merges with a straight section 48 of the lateral contour at the lateral merging point 28. The lateral straight stem section 48 then extends up to a stem shoulder 50 arranged at the proximal stem section 12.

[0039] The proximal stem section 12 has a plurality of ribs 30 provided on anterior and posterior surfaces 32, 34 of the stem 10 in a direction parallel to the stem center axis 20. A resection line 36 is indicated in Fig. 1A.

[0040] The ribs 30 stop adjacent to the resection line 36. The resection line 36 is the line at which a hip bone (proximal femur, not shown) is resected to remove the natural femoral head from the femur and the position at which the stem 10 is implanted in its place. Naturally speaking the ribs 30 can alternatively stop short of the resection line 36 or project beyond this. The portion adjacent this resection line 36 of the stem 10 is also referred to as the femoral head region of the stem 10.

[0041] The medial contour of the proximal stem section 12 is composed of a curved section Ra, Rc, Rb merging with the medial contour Rd of the collar 18 and the straight medial section 46. As can be seen from Fig. 1A the degree of curvature of the medial contour of the stem 10 increases from the merging point between the straight medial section 46 and a first curved section Ra to the merging point between a second curved section Rb and the convexly curved contour Rd of the collar 18.

[0042] In fact the curved medial section of the example shown in Fig. 1A is best described with reference to three adjacent curved sections Ra, Rc, Rb whose respective degree of curvature decreases from the collar 18 to the medial straight section 46. Moreover, the different merging points of the different curved sections are selected such that a pair of adjacent sections have a common tangent at their common merging point.

[0043] Generally speaking the first curved section has a radius of curvature Ra which is in the range from 50 to 150 mm, in particular in the range of 80 mm to 120 mm and in the example of Fig. 1A has a radius of curvature of approximately 100 mm.

[0044] The second curved section has a radius of curvature Rb which is in the range from 5 to 25 mm, in particular in the range of 10 mm to 20 mm and in the example of Fig. 1A has a radius of curvature of approximately 15 mm.

[0045] The third curved section has a radius of curvature Rc which is in the range of 15 mm to 45 mm, in particular in the range of 20 mm to 40 mm and in the example of Fig. 1A has a radius of curvature of approximately 30 mm. The collar 18 in the example of Fig. 1A has a radius of curvature in the range of 3 mm to 25 mm,

but in the context of this application is not restricted to any specific curved shape, providing it is a convexly shaped part.

[0046] Inspecting the distal stem section 14, we see that the distal tip 26 is arranged adjacent to the distal end 24 and defines a distalmost point of the distal end 24. The distal end 24 has a generally convexly curved outer contour R1, R2, R3 whose maximum lies at the distal tip 26, and whose respective curved sections merge with the medial merging point 22 and the lateral merging point 28. Again the distal end region 24 of the present example can also be described by three curved sections R1, R2, R3 which respectively merge at common merging points. Again each pair of adjacent sections has a common tangent at their merging point.

[0047] A radius of curvature R3 of the curved section extending between the medial merging point 22 and the distal tip 26 has a radius of curvature R3 which can be selected from the range of 0 to 5 mm depending on the size of the stem used and in the present example corresponds to approximately 2.2 mm.

[0048] Moreover, the radius of curvature R2 of the section extending between the distal tip 26 and the third curved section R1 has a size which lies in the range of 2 to 20 mm and in the example of Fig. 1A has a size of approximately 7.1 mm.

[0049] The radius of curvature R1 of the further section merging with the lateral straight section 48 can be selected in a range from 100 mm to 200 mm and in the present example of Fig. 1A is approximately 150 mm.

[0050] It is due to the lateral outer contour R1, R2 of the convexly shaped distal end 24 which ensures the reduction of the stresses following the insertion of the stem 10 into the femur. This is because the curved section better deflects or distributes peak forces arising under load.

[0051] Generally speaking the distal tip 26 is medially offset with respect to the stem center axis 20 by a distance T. The distance T is proportional to the width W of the stem 10 at the height of the medial merging point 22. The distance T may be selected according to the following relationship: $0.25 * W/2 \leq T \leq 0.75 * W/2$. In the present example of Fig. 1A the distance T is approximately 5 mm and the width W is approximately 18 mm.

$$0.25 * W/2 \leq T \leq 0.75 * W/2.$$

[0052] Fig. 1B shows a medial side view of the stem of Fig. 1A. As can be seen from Fig. 1B, the anterior and posterior surfaces 32, 34 of the distal stem section 14 are generally planar. The anterior and posterior surfaces 32, 34 are also provided with ribs 30 in the proximal stem section 12.

[0053] The stem 10 generally tapers from the most proximal point of the proximal stem section 12 to the distal tip 26.

[0054] Fig. 2 shows an outline of a stem 10 without a modular femoral neck 16 inserted at the collar 18 in solid lines and a comparison to a single piece prior art stem 10' indicated by the dashed lines. As is indicated by the arrows, the radius of curvature Ra, Rc, Rb of the concavely shaped medial contour is clearly different to that of the prior art one piece stem 10'.

[0055] It has surprisingly found that this larger stem body of the stem 10 still permits a good insertion into the patient's femur even though the convexly shaped collar 18 is provided. The resection line 36 is also indicated.

[0056] Fig. 3A shows a further embodiment of a straight stem 10. In the present example a plurality of sectional lines are indicated in the illustration of Fig. 3A. The sectional lines AA, HH, BB, GG and CC show the substantially rectangular shape of the cross-section of the stem 10 as is depicted in Figs. 3B to 3F. The cross-sections of the proximal stem section 12 of the stem 10 shown in Figs. 3B and 3C shows how the height of the ribs 30 increases from a lateral side of the stem 10 to a medial side of the stem 10.

[0057] Moreover, the section along the line DD shown in Fig. 3G, clearly shows a recess 38 provided in the stem 10 for the reception of the modular femoral neck 16.

[0058] Fig. 3H shows an enhanced view of the curved distal end region 24 of the stem 10. From this drawing one can clearly see that the medial merging point 22 is far closer to the distal tip 26 than the lateral merging point 28, as measured along the stem center axis 20.

[0059] Thus, the asymmetry of the contour of the distal end 24 is in this example due to the medial offset of the distal tip 26 with respect to the stem center axis 20 and the proximal offset of the lateral merging point 28 with respect to the medial merging point 22. In other embodiments not presented here, only one of these offsets may be provided without leaving the scope of the present disclosure.

[0060] Fig. 3I shows a view onto the stem 10 in the direction M of 3A and shows the generally planar surfaces of the posterior and anterior surfaces of the distal region of the stem of Fig. 3A.

[0061] Fig. 3J shows a view onto the proximal top side of the stem 10 in the direction N of Fig. 3A. A recess 40 for a stem extractor (not shown) is provided. Moreover, the recess 38 for inserting the modular femoral neck 16 can also be seen. At the end of the stem 10 is a small hole 42 which is generally the interface to an impaction instrument (not shown), i.e. the tool which is used for the insertion of the modular femoral head 16.

[0062] Generally speaking the stem 10 has a proximal primary fixation which is achieved by a press fit of the stem 10 in the femur. The general cross-section of the stem 10 can best be described as being primarily rectangular, and increasing sizes of stems 10 are wider in the medial-lateral direction than in the proximal-distal direction and are all based on an at least similar medial curved contour Ra, Rc, Rb. The number of ribs 30 and the an-

terior-posterior width also increases with an increase in size of these stems 10. The stem 10 is generally intended to be used for cement-less implant for total hip arthroplasty.

[0063] Fig. 4 shows a further embodiment of a straight stem 10. In the example of Fig. 4 the ribs 30 are aligned generally perpendicular to the stem center axis 20. Generally speaking the alignment of the ribs 30 can be selected at random.

[0064] Fig. 4 also shows how a straight stem 10 can be realized with a shoulder portion 50 which is less pronounced when compared to the shoulder portion of the stem 10 depicted in Figs. 1A to 3J. Adjacent the modular femoral neck 16 are a series of dots 44. These dots 44 indicate a typical variation of the position of a femoral head (not shown) which indicates the flexibility a surgeon has when using the modular femoral neck 16 in combination with the stem 10 presented here.

[0065] The present disclosure also refers to a set of straight stems as disclosed herein having different sizes, wherein at least a plurality of differently sized stems within the set have the same degree of curvature, in particular the same radius of curvature, for their convexly curved lateral section R1 of the distal end 24, in particular R1 being at least approximately 150mm, and/or for their concavely curved medial section Ra of the medial contour of the stem, in particular Ra being at least approximately 100mm.

[0066] The description of the disclosure is merely exemplary in nature, and, thus, variations do not depart in the gist of the disclosure are intended to be within the scope of the disclosure. Such variations are not to be regarded as a departure from the spirit in the scope of the disclosure.

List of Reference Numerals:

[0067]

10	straight stem
12	proximal stem section
14	distal stem section
16	modular femoral neck
18	collar
20	stem center axis
22	medial merging point
24	distal end
26	distal tip
28	lateral merging point
30	ribs
32	anterior surface
34	posterior surface
36	resection line
38	recess
40	recess
42	hole
44	dots
46	medial straight section
48	lateral straight section
50	shoulder
R1 to R3	distal contour of distal end region
Ra to Rd	medial contour of stem
T	distance
W	width

Claims

1. A straight stem (10) for the implantation into a proximal femur, the stem (10) comprising a proximal stem section (12) and a distal stem section (14) having a distal end (24), the proximal stem section (12) comprising a connection portion for connecting a neck (16) to the stem (10), the connection portion comprising a collar (18) having, in an anterior-posterior view, a medial contour,
the stem (10) having, in an anterior-posterior view, a medial contour and a lateral contour, and
the stem (10) having a straight stem center axis (20) between the medial contour and the lateral contour,
wherein the medial contour of the stem (10) comprises a concavely curved section extending between a straight medial section (46) and the collar (18),
wherein the concavely curved section of the medial contour comprises at least first and second curved sections, the first curved section merging with the straight medial section (46) and the second curved section merging with the medial contour of the collar (18), and
wherein the degree of curvature of the first curved section is smaller than the degree of curvature of the second curved section.

2. A straight stem (10) in accordance with claim 1, wherein the medial contour of the collar (18) is convexly curved.

3. A straight stem (10) in accordance with claim 1, wherein the first and second curved sections of the medial contour have a radius of curvature Ra and Rb, respectively, and wherein $5 * Rb \leq Ra \leq 10 * Rb$.

4. A straight stem (10) in accordance with any one of the preceding claims, wherein the medial contour of the stem (10) has at least one third curved section between the first and second curved sections, the degree of curvature of the third curved section being different from the degrees of curvature of the first and second curved sections.

5. A straight stem (10) in accordance with any one of the preceding claims, wherein the third curved section has a radius of curvature Rc, and wherein $Rb < Rc < Ra$, in particular wherein $2 * Rc \leq Ra \leq 5 * Rc$.

6. A straight stem (10) in accordance with any one of the preceding claims, wherein the degree of curvature of the medial contour of the stem (10) increases from the merging point between the straight medial section (46) and the first curved section to the merging point between the second curved section and the convexly curved contour of the collar (18).

7. A straight stem (10) in accordance with any one of the preceding claims, wherein adjacent ones of the sections of the medial contour of the stem (10) and of the collar (18) merge at a common point, and wherein each pair of adjacent sections have a common tangent at their common point.

8. A straight stem (10) in accordance with any one of the preceding claims, wherein the first curved section has a radius of curvature Ra which is in the range of 50mm to 150mm, in particular in the range of 80mm to 120mm, and/or wherein the second curved section has a radius of curvature Rb which is in the range of 5mm to 25mm, in particular in the range of 10mm to 20mm, and/or wherein the third curved section has a radius of curvature Rc which is in the range of 15mm to 45mm, in particular in the range of 20mm to 40mm.

9. A straight stem (10) in accordance with any one of the preceding claims, wherein the distal stem section (14) has a distal tip (26) arranged directly adjacent the distal end (24) and defining a distalmost point of the distal end (24), wherein the distal end (24), in an anterior-posterior view, has a convexly curved contour, and wherein the convexly curved contour of the distal end (24) merges with straight sections (46, 48) of the medial contour and of the lateral contour at a medial merging point (22) and a lateral merging point (28), respectively, wherein the medial merging point (22) and the lateral merging point (28) are offset with respect to each other in a direction parallel to the stem center axis (20), and wherein the lateral merging point (28) is arranged proximally with regard to the medial merging point (22).

10. A straight stem (10) in accordance with any one of the preceding claims 1 to 8, wherein the distal stem section (14) has a distal tip (26) arranged directly adjacent the distal end (24) and defining a distalmost point of the distal end (24), wherein the distal end (24), in an anterior-posterior view, has a convexly curved contour, and wherein the convexly curved contour of the distal end (24) merges with straight sections (46, 48) of the medial contour and of the lateral contour at a medial merging point (22) and a lateral merging point (28), respectively, wherein the convexly curved contour of the distal end (24) is such that the distal tip (26) is medially offset with respect to the stem center axis (20).

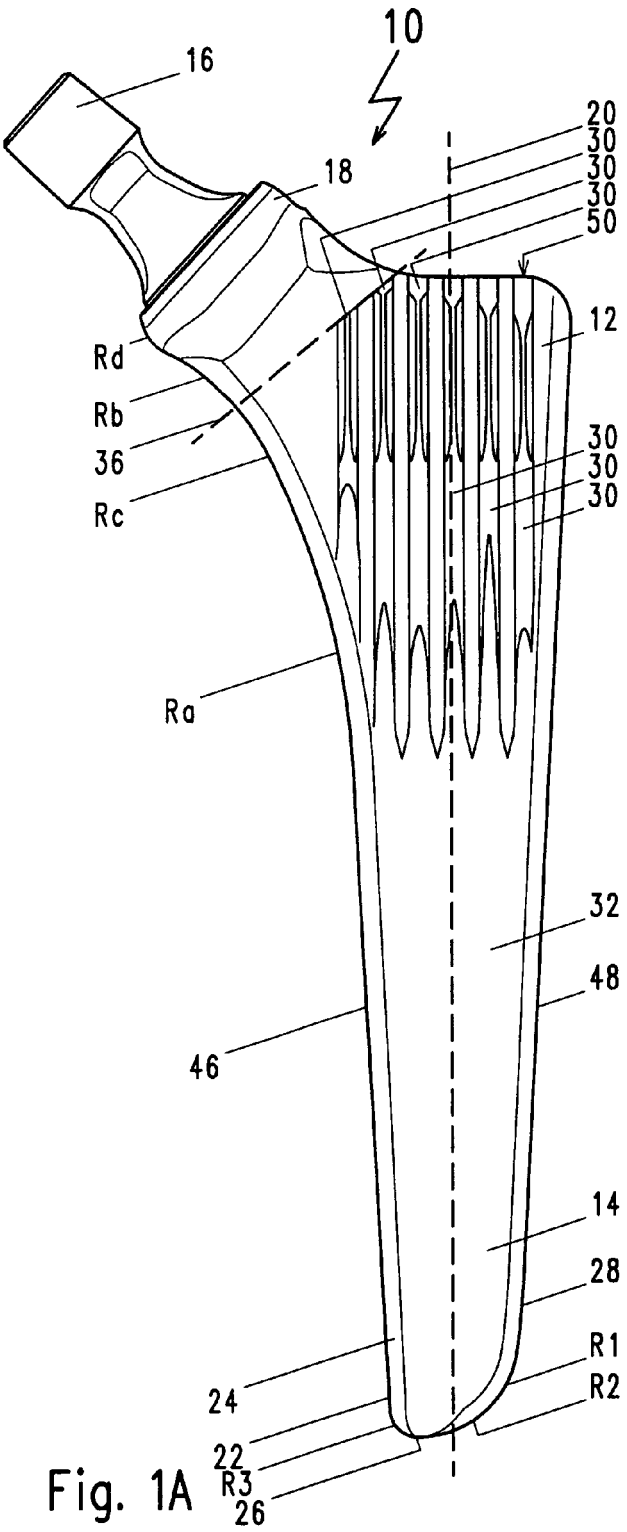
11. A straight stem (10) in accordance with claim 9 or 10, wherein the convexly curved contour of the distal end (24) has a curved medial section extending between the distal tip (26) and the medial merging point (22) and a curved lateral section extending between the distal tip (26) and the lateral merging point (28), and wherein the contour of the distal end (24) is asymmetrically convexly curved such that the degree of curvature of the curved lateral section is smaller than the degree of curvature of the curved medial section.

12. A straight stem (10) in accordance with any one of claims 9 to 11, wherein the curved lateral section of the distal end (24) is defined by at least one radius of curvature R1, and wherein $100mm \leq R1 \leq 200mm$.

13. A straight stem (10) in accordance with any one of the preceding claims, wherein the stem (24) has a lateral shoulder (50), the stem center axis (20) extending between the distal end (24) and the lateral shoulder (50), in particular wherein a straight section (48) of the lateral contour of the stem (10) extends from the distal end (24) to the lateral shoulder (50).

14. A straight stem (10) in accordance with any one of the preceding claims,
wherein in a transverse plane the cross section of the stem (10) has a generally rectangular shape along the stem center axis (20) between the distal end (24) and the lateral shoulder (50).

15. A straight stem (10) in accordance with any one of the preceding claims,
wherein the stem (10) has an anterior surface (32) and a posterior surface (34) which are substantially planar at least in the distal stem section (14), and
wherein the stem (10) tapers towards the distal end (24) in a frontal plane as well as in a sagittal plane, the frontal plane taper being defined by straight sections (46, 48) of the medial and the lateral contours of the stem (10), and the sagittal plane taper being defined by the planar anterior and posterior surfaces (32, 34) of the stem (10).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36
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R3
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Fig. 1A

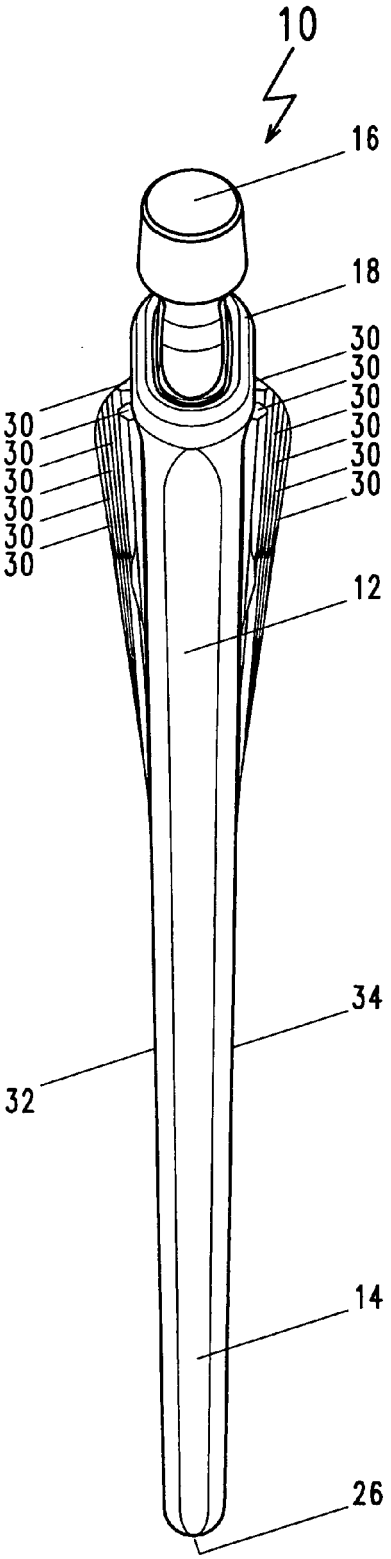
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Fig. 1B

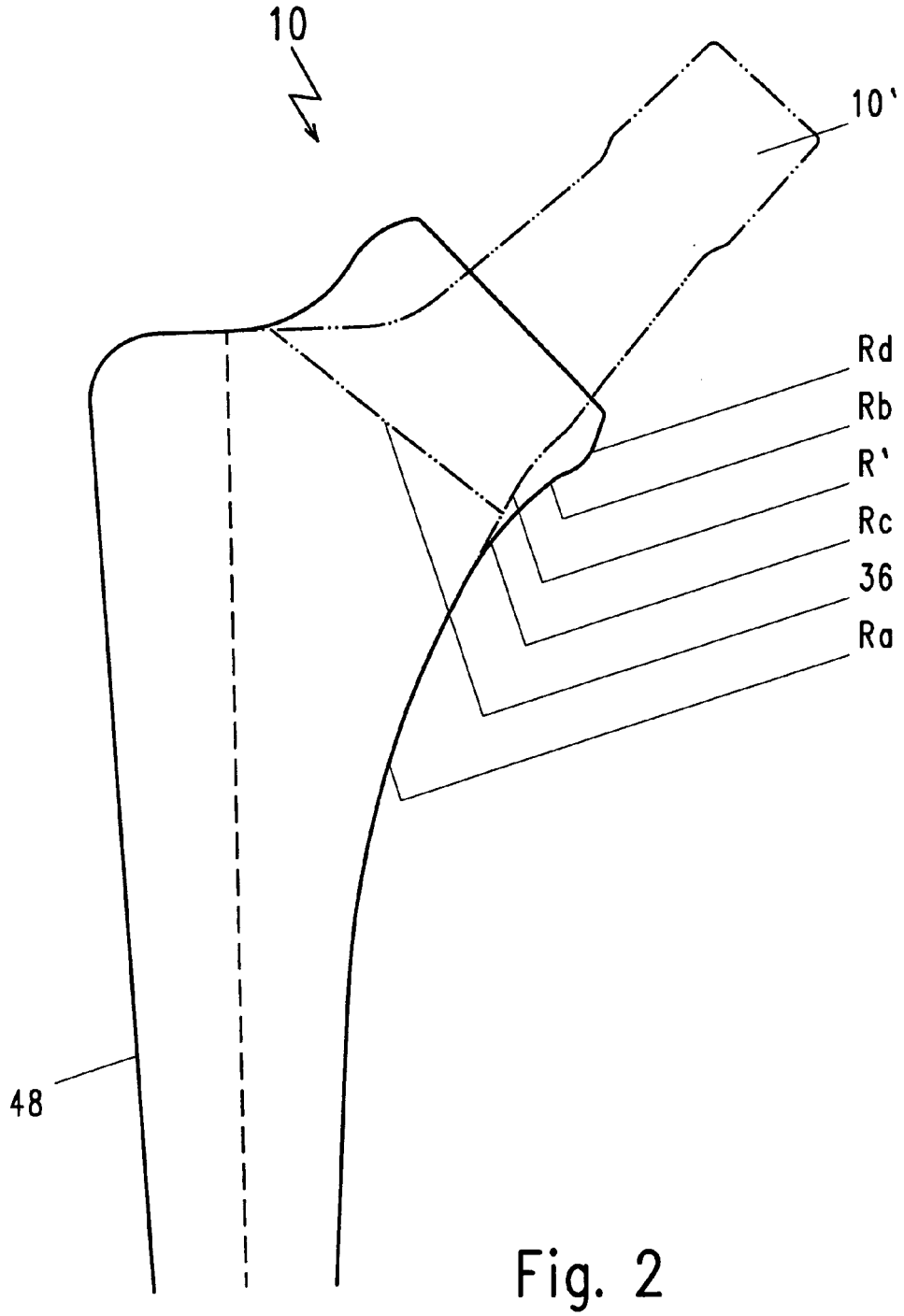


Fig. 2

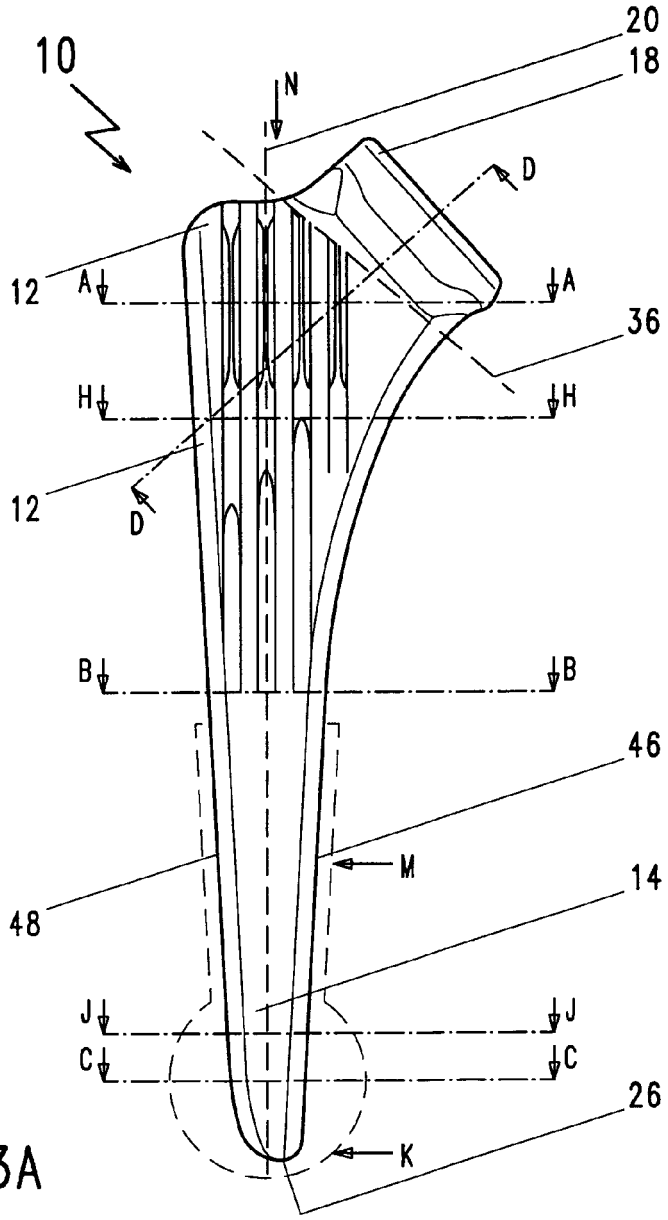
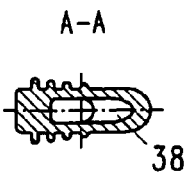


Fig.3A



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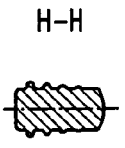

Fig.3C

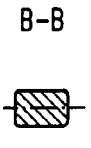

Fig.3D

Fig.3E

Fig.3F

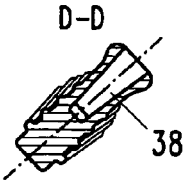

Fig.3G

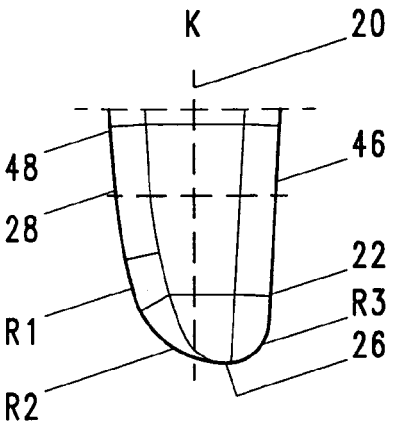

Fig.3H

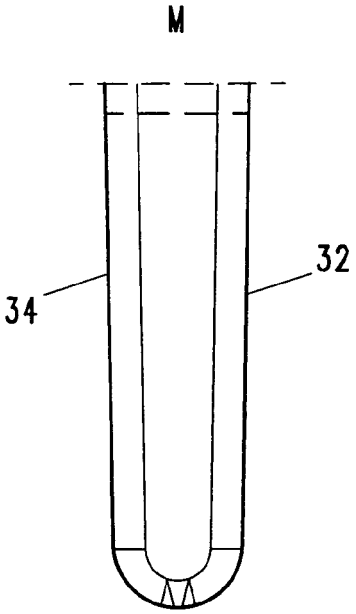

Fig.3I

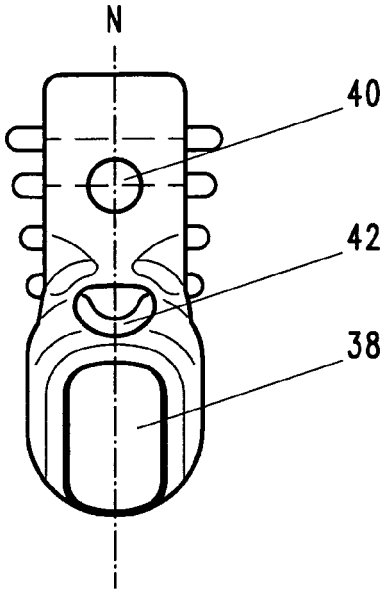

Fig.3J

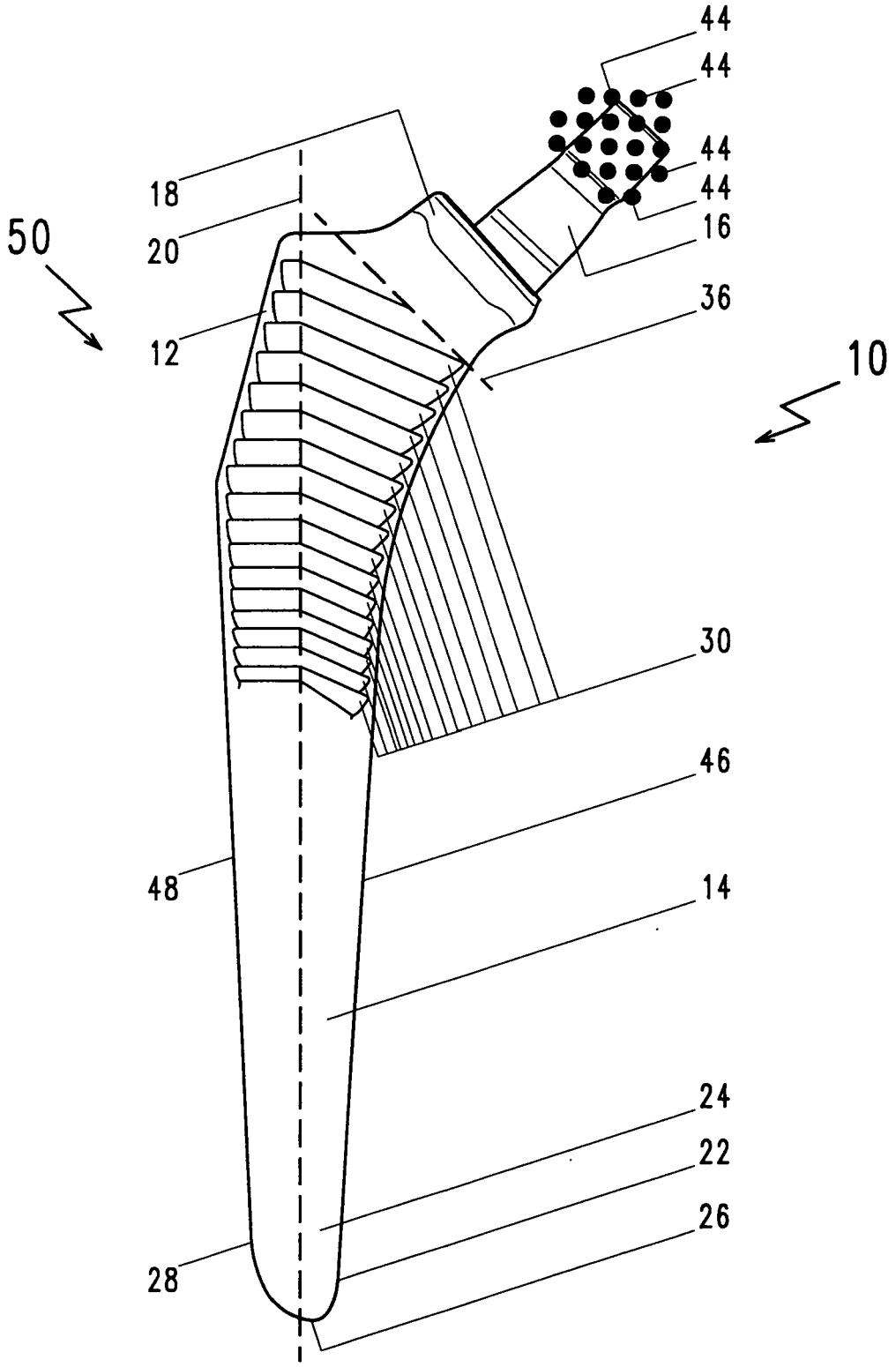

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 11 00 0659

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2007/043448 A1 (MURRAY IAN P [US]) 22 February 2007 (2007-02-22) * figures 14-21 * * paragraphs [0087], [0131] *	1-15	INV. A61F2/36
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TECHNICAL FIELDS SEARCHED (IPC)

A61F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 June 2011	Josten, Stefan

CATEGORY OF CITED DOCUMENTS

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